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UTILITY PATENT APPLICATION TRANSMITTAL <small>(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))</small>	Attorney Docket No.	LE9-00-022
	First Inventor or Application Identifier	Paul Timothy Spivey
	Title	Heater Chip for an InkJet Printhead
	Express Mail Label No.	EJ946017280US

APPLICATION ELEMENTS <small>See MPEP chapter 600 concerning utility patent application contents.</small>	ADDRESS TO: Assistant Commissioner for Patents Box Patent Application Washington, DC 20231
1. <input checked="" type="checkbox"/> * Fee Transmittal Form (e.g., PTO/SB/17) <small>(Submit an original and a duplicate for fee processing)</small>	5. <input type="checkbox"/> Microfiche Computer Program (Appendix)
2. <input checked="" type="checkbox"/> Specification [Total Pages 8] <small>(preferred arrangement set forth below)</small> <ul style="list-style-type: none">- Descriptive title of the Invention- Cross References to Related Applications- Statement Regarding Fed sponsored R & D- Reference to Microfiche Appendix- Background of the Invention- Brief Summary of the Invention- Brief Description of the Drawings (if filed)- Detailed Description- Claim(s)- Abstract of the Disclosure	6. Nucleotide and/or Amino Acid Sequence Submission (if applicable, all necessary) <ul style="list-style-type: none">a. <input type="checkbox"/> Computer Readable Copyb. <input type="checkbox"/> Paper Copy (identical to computer copy)c. <input type="checkbox"/> Statement verifying identity of above copies
3. <input checked="" type="checkbox"/> Drawing(s) (35 U.S.C. 113) [Total Sheets 8]	ACCOMPANYING APPLICATION PARTS 7. <input checked="" type="checkbox"/> Assignment Papers (cover sheet & document(s)) 8. <input type="checkbox"/> 37 C.F.R. § 3.73(b) Statement <input checked="" type="checkbox"/> Power of Attorney <small>(when there is an assignee)</small> 9. <input type="checkbox"/> English Translation Document (if applicable) 10. <input checked="" type="checkbox"/> Information Disclosure Statement (IDS)/PTO-1449 <input checked="" type="checkbox"/> Copies of IDS Citations 11. <input type="checkbox"/> Preliminary Amendment 12. <input checked="" type="checkbox"/> Return Receipt Postcard (MPEP 503) <small>(Should be specifically itemized)</small> 13. <input type="checkbox"/> * Small Entity Statement filed in prior application under Box 4b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts. <small>(PTO/SB/09-12)</small> <input type="checkbox"/> Status still proper and desired 14. <input type="checkbox"/> Certified Copy of Priority Document(s) (if foreign priority is claimed) 15. <input type="checkbox"/> Other:
4. Oath or Declaration [Total Pages 3] <ul style="list-style-type: none">a. <input checked="" type="checkbox"/> Newly executed (original or copy)b. <input type="checkbox"/> Copy from a prior application (37 C.F.R. § 1.63(d)) <small>(for continuation/divisional with Box 16 completed)</small><ul style="list-style-type: none">i. <input type="checkbox"/> <u>DELETION OF INVENTOR(S)</u> Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).	
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APPLICATION FOR UNITED STATES LETTERS PATENT

For

HEATER CHIP FOR AN INKJET PRINTHEAD

By

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Carl E. Sullivan
Kent L. Ubellacker

006340346360

HEATER CHIP FOR AN INK JET PRINTHEAD

BACKGROUND OF THE INVENTION

1. Field of the invention.

The present invention relates to ink jet printheads, and, more particularly, to a heater chip for an ink jet printhead.

2. Description of the related art.

5 A printhead in an ink jet printer includes a silicon heater chip 10 (Fig. 1a), also termed a “die,” containing a plurality of heating devices (not shown). Chip 10 has a single via 12. However, it is also possible for a chip to have multiple vias 12, such as chip 14 (Fig. 1b) or chip 16 (Fig. 1c). Other variations are of course possible. Each via 12 supplies ink from the backside of the heater chip to the front side of the chip,
10 which is where the heating devices are located.

It is known for a line of die attach adhesive to be dispensed onto a substrate in order to attach the heater chip to the substrate. Since adjacent ones of vias 12 may carry different colors of ink, the line of die attach adhesive must seal around and between each via 12 in order to prevent the inks from mixing together. A problem is
15 that there are no features on the backside of the chips to control the die attach adhesive flow during placement and cure.

To meet the increasing demands on ink jet print quality, the packaging technology must provide better thermal management, more efficient use of space, and precision alignment of ejector nozzles. For thermal management, the die attach
20 adhesive plays a key role. The bond line must be controlled in every dimension. Both the placement, in relation to the substrate and via, and the thickness of the bond line are important. As it is attempted to incorporate more devices on each chip, more chips on each head, and all in a smaller package, there is less room for making the necessary ink seals.

25 In one known method, die attach adhesive 18 (Fig. 2a) is dispensed onto a substrate 20, and a chip 22 is brought into contact with adhesive 18. Adhesive 18 is forced to flow laterally as chip 22 is lowered into place in the direction indicated by

arrow 24 (Fig. 2b). This lateral flow of adhesive 18 can result in a very wide bond line in the X direction as the height of the bond line in the Z direction is decreased.

What is needed in the art is a heater chip that can be adhered to a substrate such that greater control of the die attach adhesive is maintained.

5

SUMMARY OF THE INVENTION

The present invention provides a heater chip with a trench on its backside for controlling the die attach adhesive.

The invention comprises, in one form thereof, an ink jet printhead assembly. The printhead assembly includes a heater chip having a backside with at least one cavity. A substrate is associated with the backside of the heater chip. Adhesive is at least partially disposed within the at least one cavity. The adhesive adheres the backside of the heater chip to the substrate.

An advantage of the present invention is that the flow of the die attach adhesive can be precisely controlled.

Another advantage is that a very accurate and precise bond line is provided.

Yet another advantage is that a greater surface area of the chip is available for bonding over a given X distance on the chip.

A further advantage is that, for a set amount of adhesive, the height of the bond line in the Z direction and the width of the bond line in the X direction are greatly decreased.

BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention will be better understood by reference to the following description of embodiments of the invention taken in conjunction with the accompanying drawings, wherein:

Fig. 1a is a backside view of a known heater chip with a single via;

Fig. 1b is a backside view of a known heater chip with multiple vias;

Fig. 1c is a backside view of another known heater chip with multiple vias;

Fig. 2a is a side view of a first step in adhering a known heater chip to a substrate;

Fig. 2b is a side view of a second step in adhering a known heater chip to a substrate;

Fig. 3 is a backside view of a first embodiment of a heater chip of the present invention;

Fig. 4a is a backside view of a second embodiment of a heater chip of the present invention;

5 Fig. 4b is a backside view of a third embodiment of a heater chip of the present invention;

Fig. 5a is a side view of a fourth embodiment of a heater chip of the present invention;

10 Fig. 5b is a side view of a fifth embodiment of a heater chip of the present invention;

Fig. 5c is a side view of a sixth embodiment of a heater chip of the present invention;

Fig. 6a is a side view of a first step in adhering the heater chip of Fig. 5a to a substrate;

15 Fig. 6b is a side view of a second step in adhering the heater chip of Fig. 5a to a substrate;

Fig. 7 is a backside view of a seventh embodiment of a heater chip of the present invention; and

20 Fig. 8 is a side view of an eighth embodiment of a heater chip of the present invention adhered to a substrate.

Corresponding reference characters indicate corresponding parts throughout the several views. The exemplifications set out herein illustrate one preferred embodiment of the invention, in one form, and such exemplifications are not to be construed as limiting the scope of the invention in any manner.

25

DETAILED DESCRIPTION OF THE INVENTION

30 In Fig. 3 there is shown one embodiment of a silicon heater chip 26 of the present invention. Heater chip 26 includes a trench 28 encircling or surrounding a single ink via 30. The pattern of trench 28 could be created through micromachining techniques or by laser ablation with, for example, an yttrium aluminum garnet (YAG) laser.

In another embodiment (Fig. 4a), a trench 32 extends to the outside edges 34 of a chip 36 in each corner of chip 36. Thus, vents 38 are provided for the die attach adhesive to outgas during cure. The pattern of trench 32 can be created through micromachining techniques, by dicing with a dicing saw, or by laser ablation with a YAG laser. In yet another embodiment (Fig. 4b), additional vents 38 are provided by use of wet or dry micromachining or laser cutting techniques.

The results of cutting into a silicon chip via micromachining, dicing and YAG laser ablation are shown in Figs. 5a, 5b and 5c, respectively. As can be seen in Fig. 5a, micromachining a chip 40 using wet chemical etch methods and (100) silicon produces a trench 42 having a triangular cross section. Such wet micromachining techniques may include the use of potassium hydroxide (KOH) or tetramethyl ammonium hydroxide (TMAN) to etch the silicon. Micromachining using dry etching techniques, such as deep reactive ion etch (DRIE) or reactive ion etch (RIE), would result in a trench having a differently shaped cross section, such as rounded or square.

As shown in Fig. 5b, dicing a chip 44 produces a trench 46 having a rectangular cross section. Finally, YAG laser ablation of a chip 48 (Fig. 5c) produces a trench 50 have a rounded cross section.

Figs. 6a and 6b illustrate the process of adhering heater chip 40 to substrate 20. In Fig. 6a, similarly to Fig. 2a, die attach adhesive 18 is dispensed onto substrate 20 and chip 40 is brought into contact with adhesive 18. In Fig. 6b, as in Fig. 2b, adhesive 18 is forced to flow laterally as chip 40 is lowered into place in the direction indicated by arrow 52. As can be seen in a comparison of Figs. 2b and 6b, trench 42 reduces the extent of the lateral flow of adhesive 18 as the height of the bond line in the Z direction is decreased. That is, trench 42 reduces the width of the bond line in the X direction. The presence of trench 42 on the backside of silicon chip 40 enables tight control over where die attach adhesive 18 is allowed to flow, which provides a very accurate and precise bond line. It is also possible for adhesive 18 to be entirely contained within the trench 42, thereby further increasing the accuracy and precision of the bond line. For a set amount of adhesive 18, the height of the bond line in the Z direction and the width of the bond line in the X direction are greatly decreased by the

presence of trench 42. Trench 42 also provides chip 40 with a greater surface area that can be bonded to over a given X distance on chip 40.

5 A precise bond line is especially important for applications that require multiple ink vias. Heater chip 54 (Fig. 7) includes multiple ink vias 56 separated by trenches 58. Since each of vias 56 may carry a different color ink, sealing between ink vias 56 is crucial to prevent cross contamination between different colored inks.

10 As the market place requires printers to have ever increasing print speeds, the delivery rate of ink to the heaters must also increase, which requires wider ink vias, such as vias 60 (Fig. 8) in heater chip 62. Wider ink vias result in the chip having less area where a seal can be established between two adjacent ink vias. By providing a greater surface area for bonding, trenches 64 improve the integrity of the bond lines in small areas, such as between multiple ink vias on a given chip.

15 While this invention has been described as having a preferred design, the present invention can be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains and which fall within the limits of the appended claims.

20

WHAT IS CLAIMED IS:

1. An ink jet printhead assembly, comprising:
a heater chip including a backside with at least one cavity;
a substrate associated with said backside of said heater chip; and
adhesive at least partially disposed within said at least one cavity, said
5 adhesive adhering said backside of said heater chip to said substrate.
2. The printhead assembly of claim 1, wherein said at least one cavity
comprises at least one trench.
3. The printhead assembly of claim 2, wherein said heater chip includes at
least one ink via.
4. The printhead assembly of claim 3, wherein said at least one trench
substantially surrounds each said via.
5. The printhead assembly of claim 4, wherein said at least one via comprises
a plurality of vias, said adhesive being configured for preventing fluid communication
between said vias in an area defined between said heater chip and said substrate.
6. The printhead assembly of claim 2, wherein said heater chip includes at
least one outside edge, said at least one trench extending to said at least one outside
edge to thereby form at least one vent.
7. The printhead assembly of claim 6, wherein said at least one vent is
configured for allowing said adhesive to outgas during curing.
8. The printhead assembly of claim 1, wherein said adhesive is substantially
entirely disposed within said at least one cavity.
9. A heater chip for use in an ink jet printhead, said heater chip including a
backside configured for being adhered to a substrate, said backside including at least
one cavity configured for receiving adhesive therein.
10. The heater chip of claim 9, wherein said at least one cavity comprises at
least one trench.
11. The heater chip of claim 10, wherein said heater chip includes at least one
ink via.
12. The heater chip of claim 11, wherein said at least one trench substantially
surrounds each said via.

13. The heater chip of claim 10, wherein said heater chip includes at least one outside edge, said at least one trench extending to said at least one outside edge to thereby form at least one vent.

14. The heater chip of claim 13, wherein said at least one vent is configured for allowing said adhesive to outgas during curing.

15. A method of assembling an ink jet printhead, said method comprising the steps of:

creating at least one cavity in a backside of a heater chip; and

5 adhering said backside of said heater chip to a substrate such that adhesive is at least partially disposed within said at least one cavity.

16. The method of claim 15, wherein said creating step includes micromachining said at least one cavity.

17. The method of claim 15, wherein said creating step includes dicing said at least one cavity.

18. The method of claim 15, wherein said creating step includes laser ablation of said at least one cavity.

19. The method of claim 15, wherein said adhering step includes the substeps of:

dispensing said adhesive onto said substrate;

aligning said at least one cavity with said adhesive; and

5 pressing said heater chip and said substrate together.

20. The method of claim 15, wherein said at least one cavity comprises at least one trench.

21. The method of claim 20, wherein said heater chip includes at least one outside edge, said at least one trench extending to said at least one outside edge to thereby form at least one vent, said method comprising the further step of allowing said adhesive to outgas through said at least one vent during curing.

ABSTRACT OF THE DISCLOSURE

An ink jet printhead assembly includes a heater chip having a backside with at least one cavity. A substrate is associated with the backside of the heater chip. Adhesive is at least partially disposed within the at least one cavity. The adhesive adheres the
5 backside of the heater chip to the substrate.

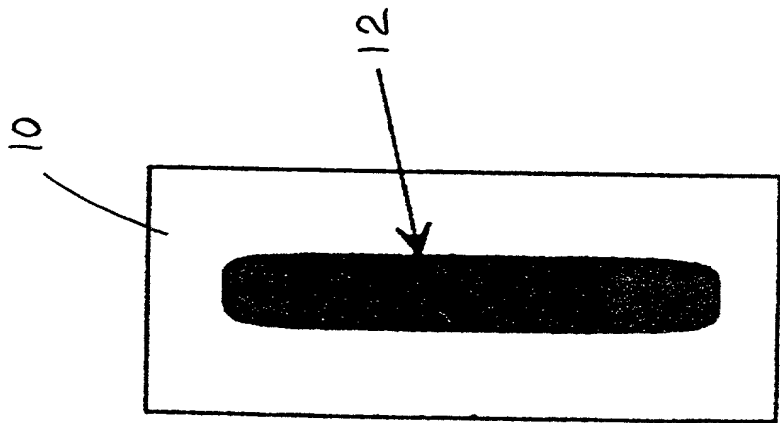


Fig. 1a
Prior art

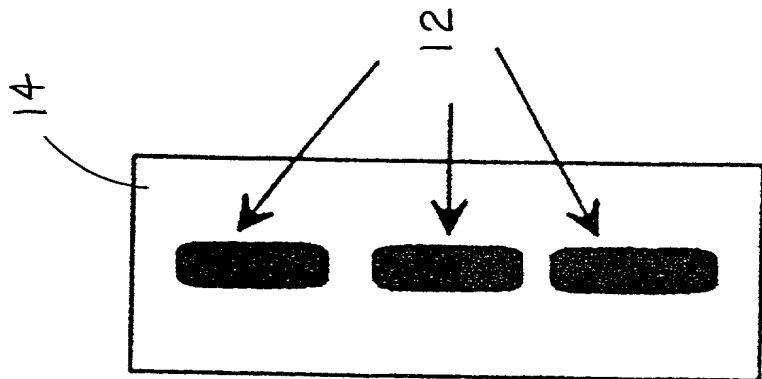


Fig. 1b
Prior art

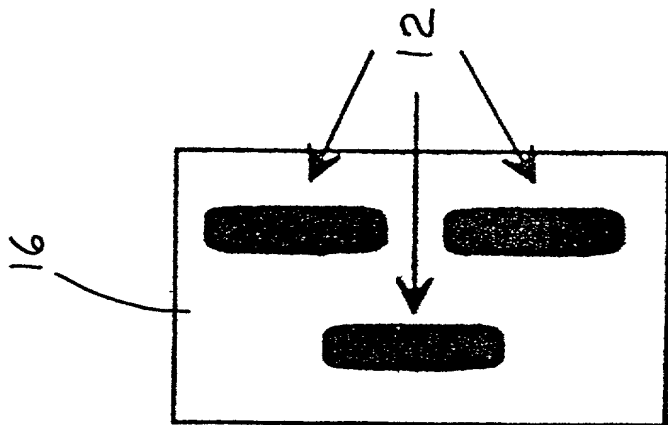


Fig. 1c
Prior art

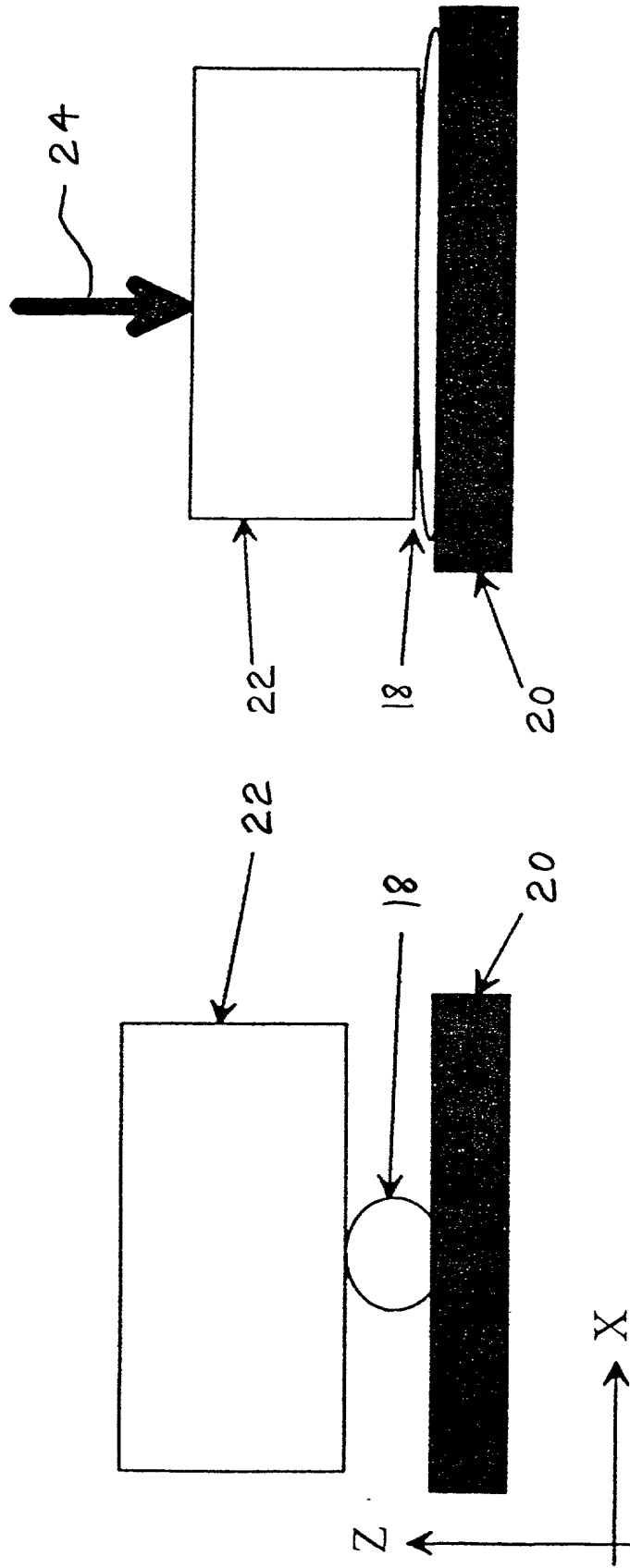


Fig. 2a
prior art

Fig. 2b
Prior art

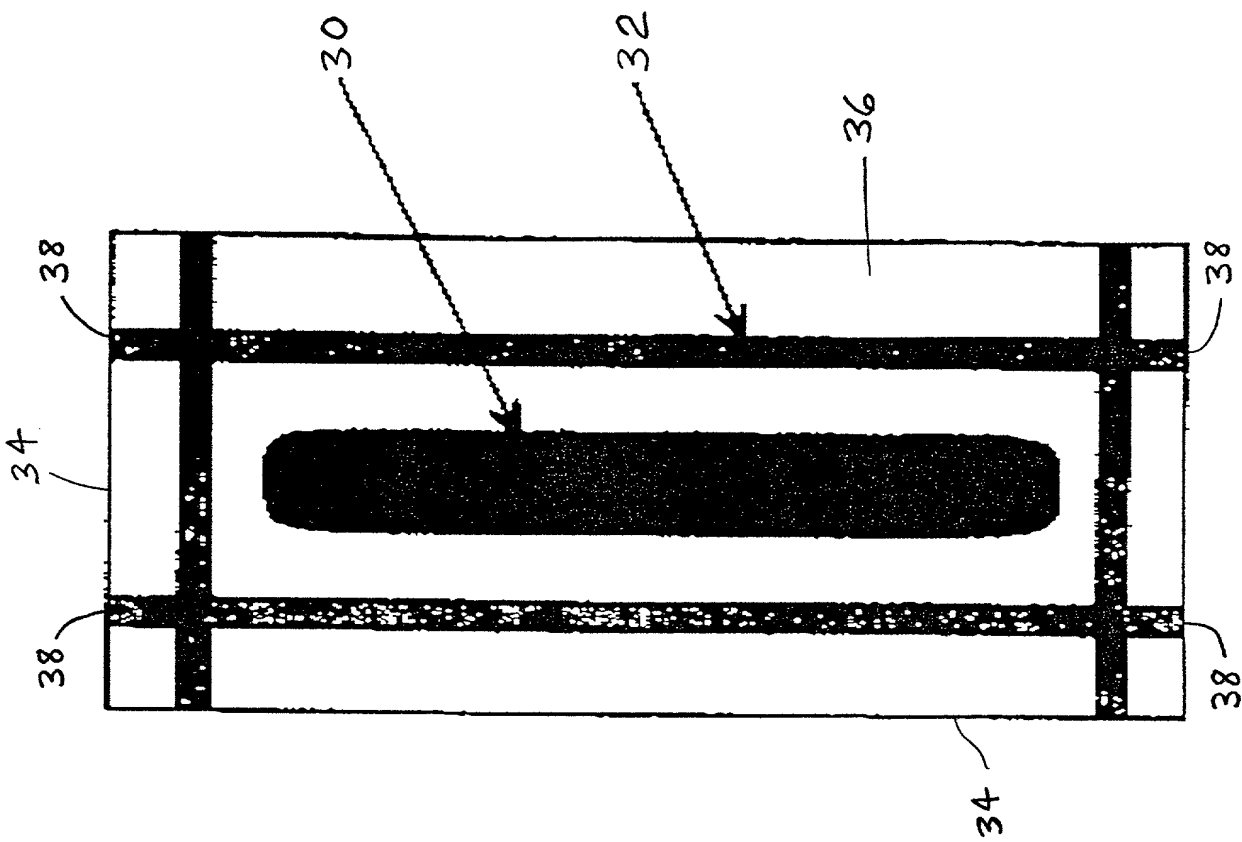
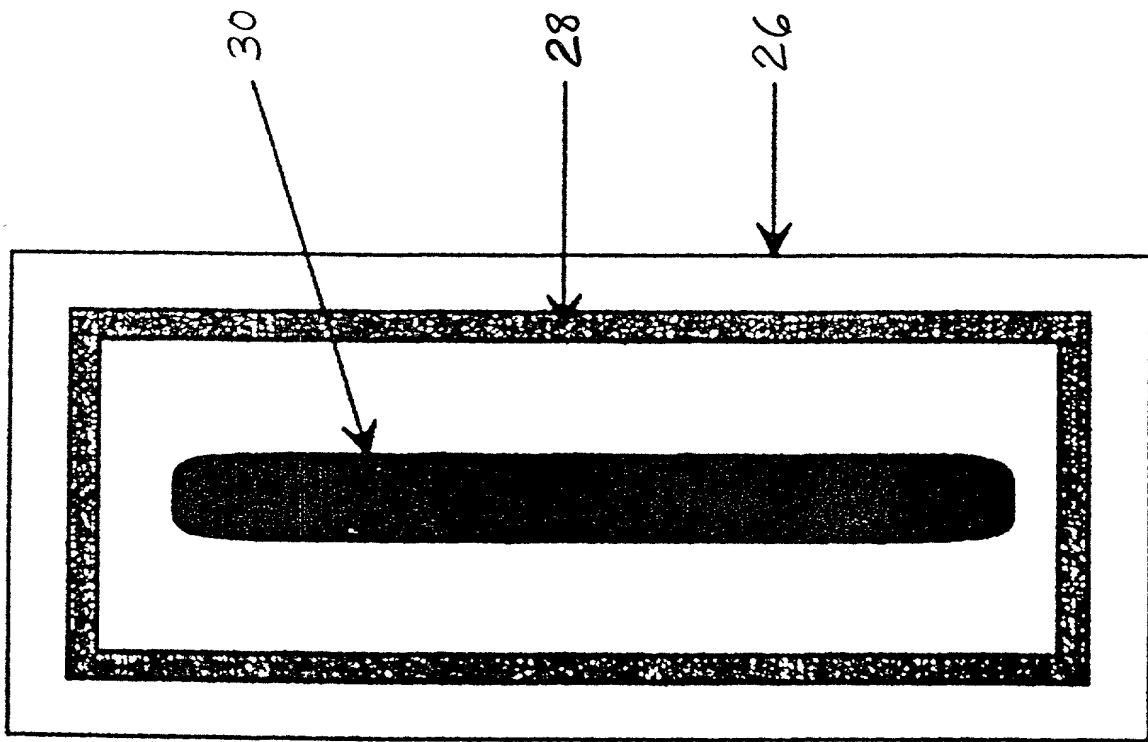
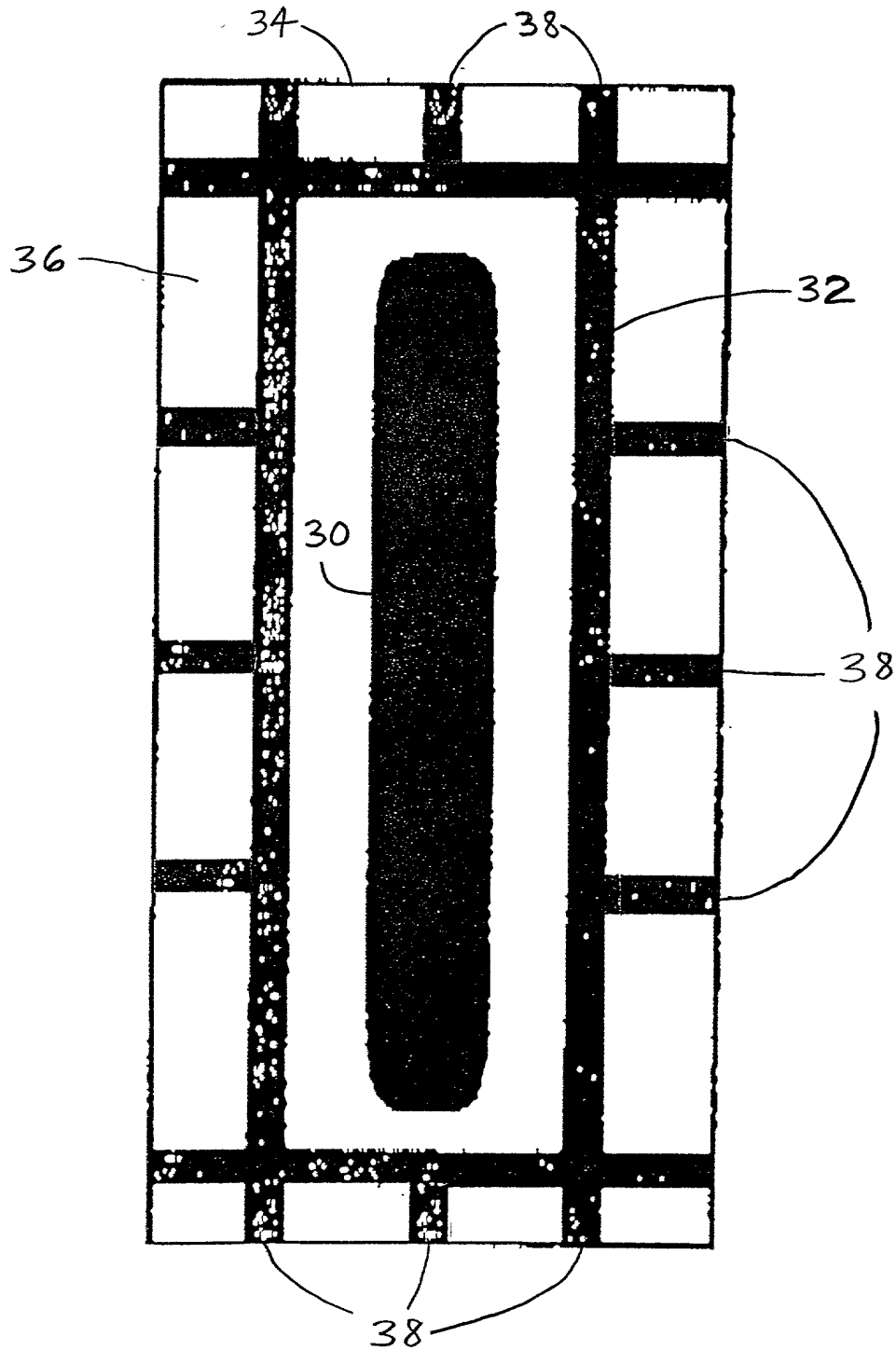


Fig. 4b



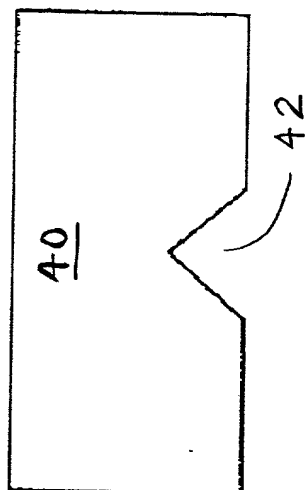


Fig. 5a

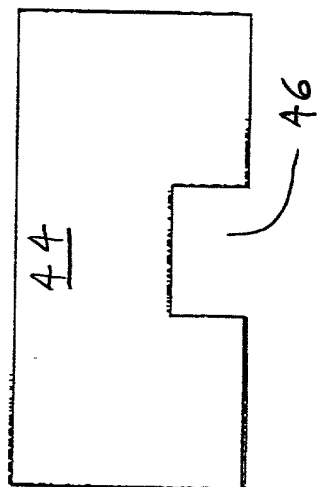


Fig. 5b

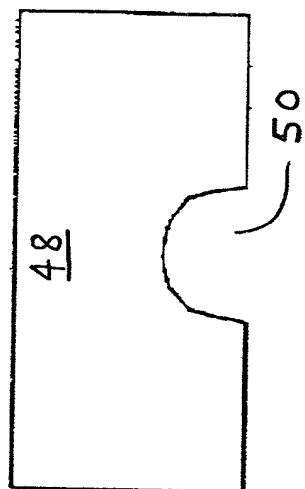
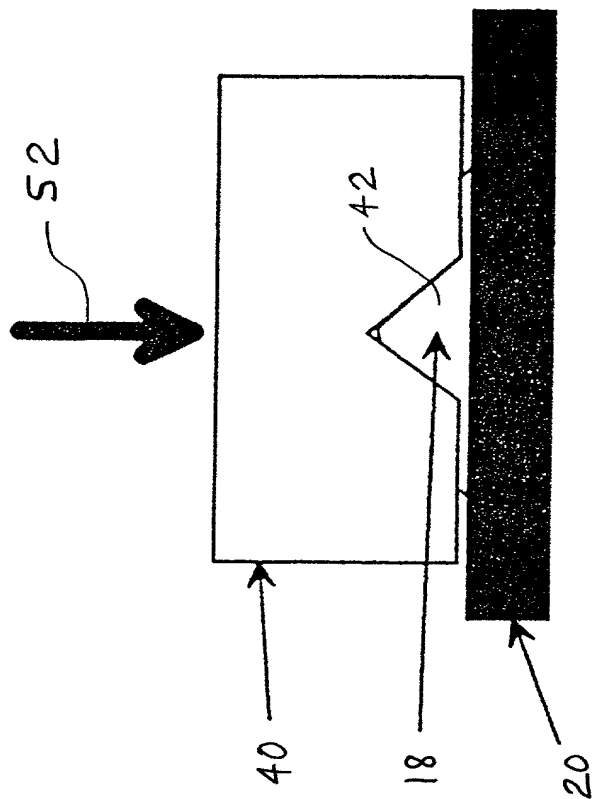
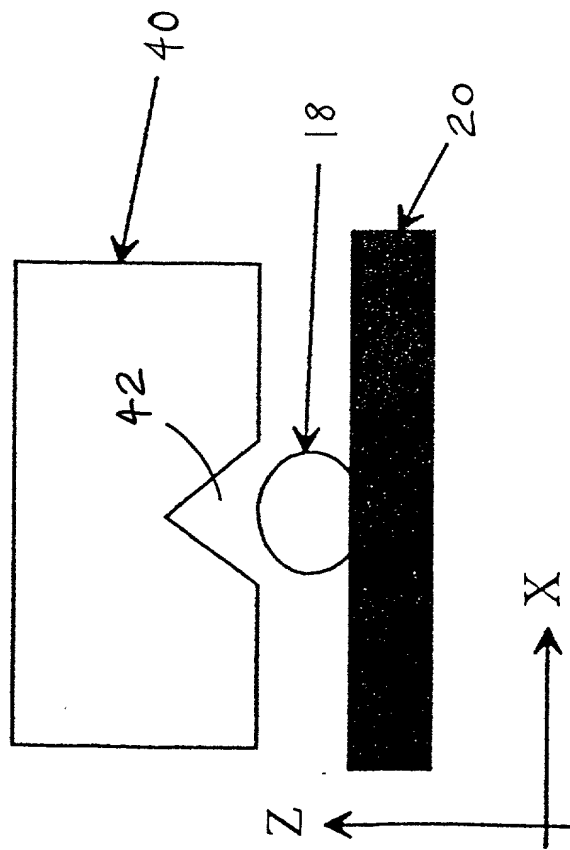


Fig. 5c



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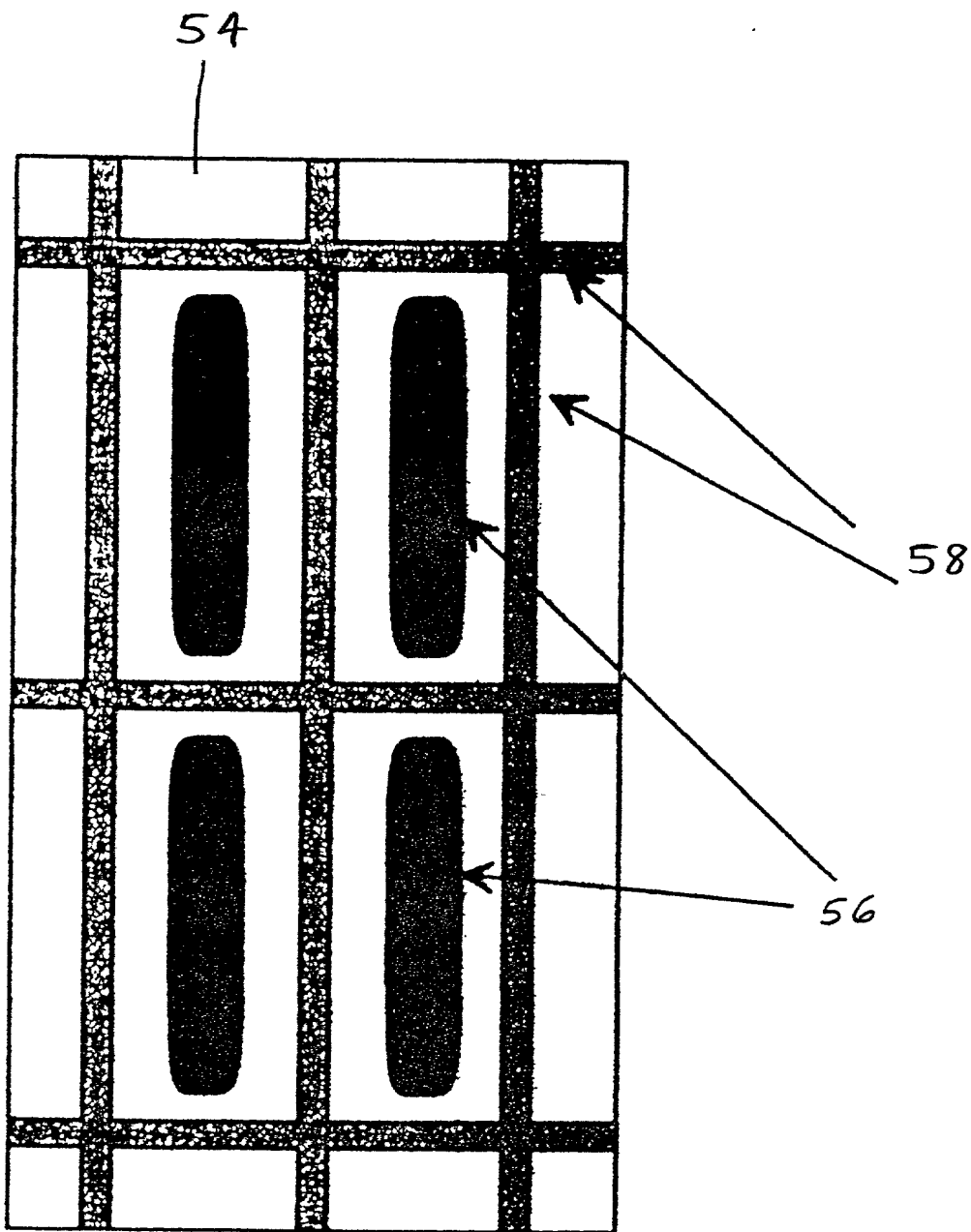


Fig. 7

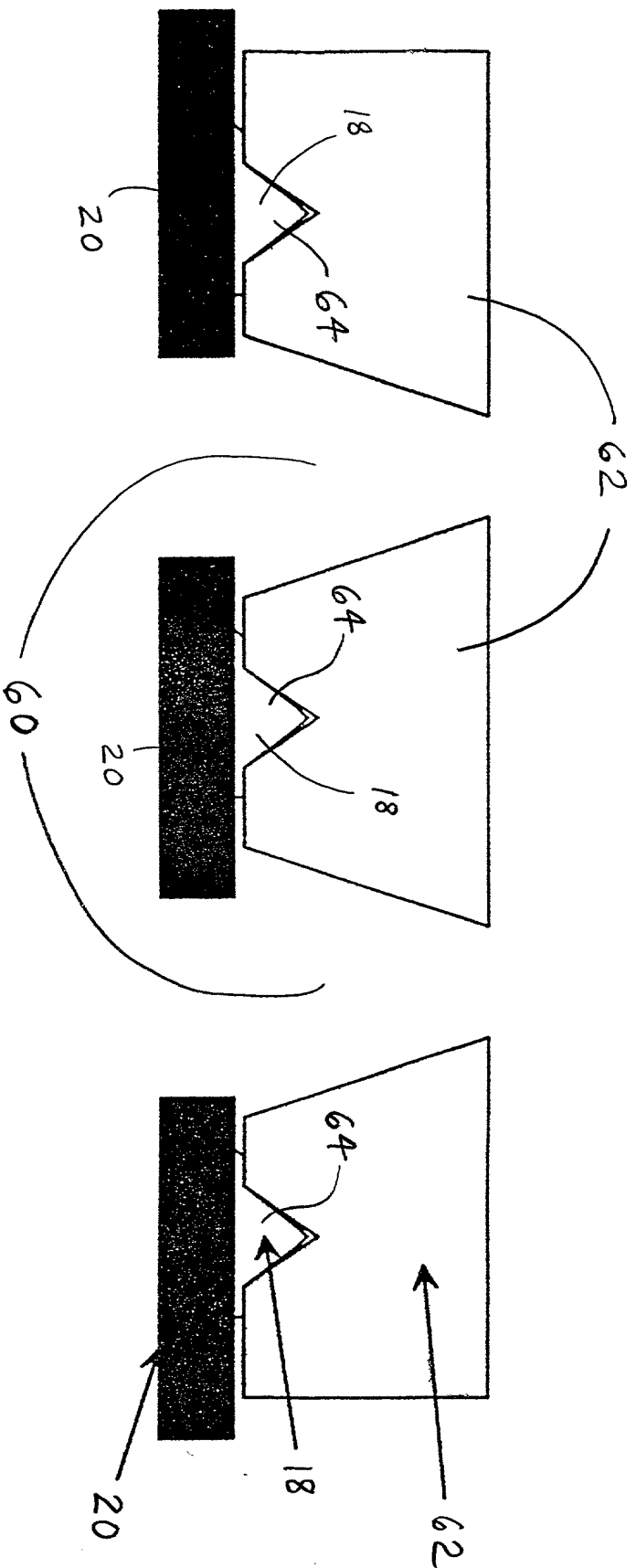


Fig. 8

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DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63) <input type="checkbox"/> Declaration Submitted with Initial Filing OR <input type="checkbox"/> Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)	Attorney Docket Number	LE9-99-125
	First Named Inventor	Spivey, Paul Timothy
	COMPLETE IF KNOWN	
	Application Number	
	Filing Date	
	Group Art Unit	
	Examiner Name	

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Heater Chip for an InkJet Printhead

the specification of which ☒ is attached hereto OR ☐ was filed on (MM/DD/YYYY) as United States Application Number or PCT International Application Number and was amended on (MM/DD/YYYY) (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 356(b) of any foreign application(s) for patent or inventor's certificate, or 356(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

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DECLARATION — Utility or Design Patent Application

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application or PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)

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Name of Sole or First Inventor: ☐ A petition has been filed for this unsigned inventor

Given Name (first and middle [if any])	Family Name or Surname
Paul Timothy	Spivey

Inventor's Signature	<i>Paul Timothy Spivey</i>			Date	7/24/00
Residence: City	Lexington	State	KY	Country	USA
Post Office Address	3550 Kenesaw Drive # 11				
Post Office Address					
City	Lexington	State	KY	ZIP	40515
				Country	US

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DECLARATION

ADDITIONAL INVENTOR(S) Supplemental Sheet Page ____ of ____

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Given Name (first and middle [if any])				Family Name or Surname			
CARL EDMOND				SULLIVAN			
Inventor's Signature	<i>Carl Edmond Sullivan</i>			Date	7-24-98		
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Post Office Address	331 CHESTNUT LANE						
Post Office Address							
City	VERSAILLES	State	KY	ZIP	40383	Country	USA
Name of Additional Joint Inventor, if any:				<input type="checkbox"/> A petition has been filed for this unsigned inventor			
Given Name (first and middle [if any])				Family Name or Surname			
KENT LEE				UBELLACKER			
Inventor's Signature	<i>Kent Lee Ubellacker</i>			Date	7/24/00		
Residence: City	GEORGETOWN	State	KY	Country	40324	Citizenship	USA
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Name of Additional Joint Inventor, if any:				<input type="checkbox"/> A petition has been filed for this unsigned inventor			
Given Name (first and middle [if any])				Family Name or Surname			
Inventor's Signature				Date			
Residence: City		State		Country		Citizenship	
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